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Engineering News-Record

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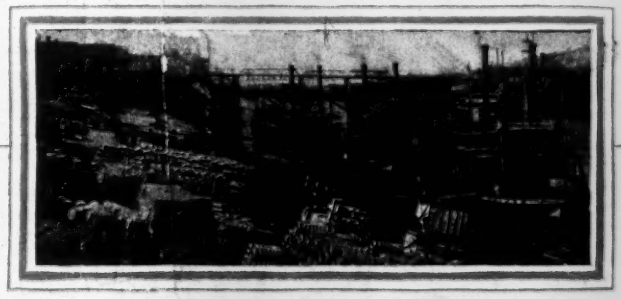
THE NEW YEAR'S NUMBER

This first-of-the-year issue has been planned with the thought of presenting reviews and editorial comment only on those phases of engineering which have shown substantial progress during 1919. The past year has been abnormal for, with the exception of the striking case of the highways, construction has been marking time.

Nevertheless the minds of engineers have been active in other channels. Throughout the country there has swept a realization by engineers of the need for raising the profession to the place it should occupy in our national life. Professional unity, compensation and licensing of engineers are subjects which have stood out at local and national gatherings of technical men during 1919

Through the medium of editorial review and special article an attempt has been made to appraise the year's results:

THE HIGHWAY SITUATION is dealt with at length in two reviews by C. S. HILL and an editorial.
THE PHYSICAL CONDITION OF THE RAILWAYS is discussed frankly and authoritatively.
ENGINEERING SOCIETY AFFAIRS, COMPENSATION, and EDUCATION are dealt with in editorials.



Beginning in This Number a Special Article Entitled:

"What is the Future of Inland Water Transportation?"

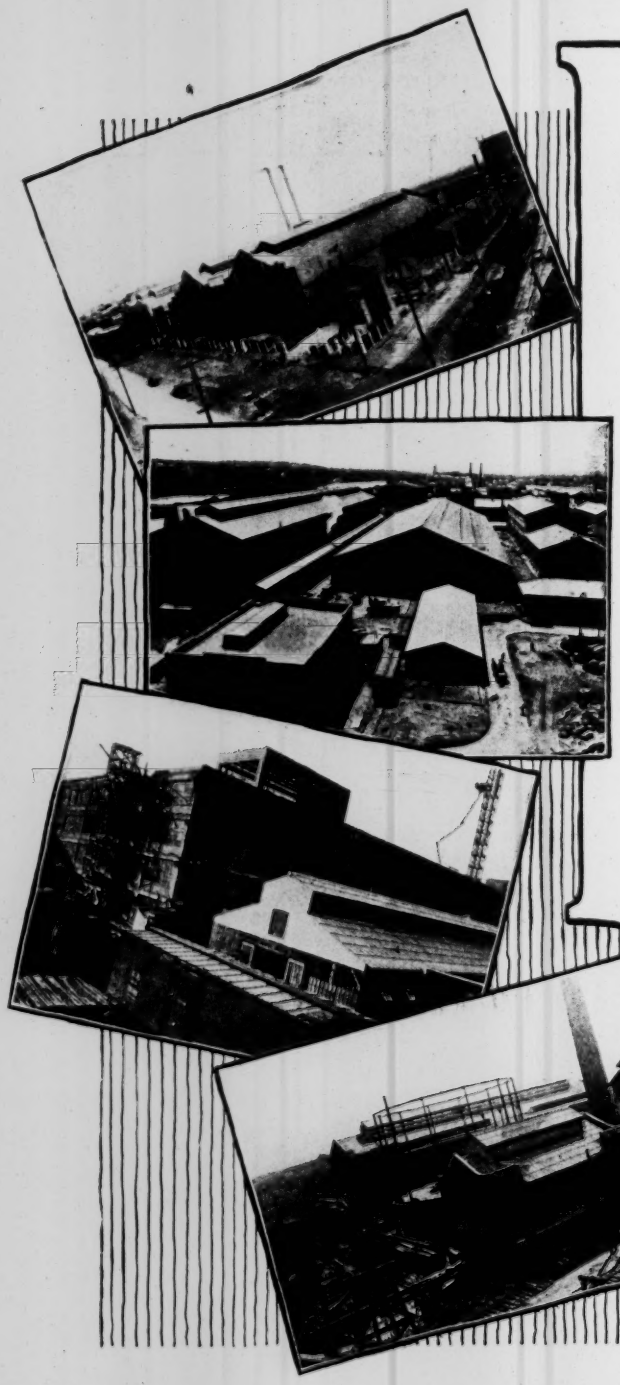
By CHARLES WHITING BAKER

merits a wide reading. It attacks such popularly held fallacies as the one that the transportation of freight by water is always cheaper than by rail, and shows that, with a few exceptions, the inland waterway, in which millions of dollars have been sunk, has failed utterly as an economic transportation factor.

Among the Other Articles Are:

"Using Concrete Proportioned by the Surface Area Method"
By R. B. YOUNG

"Engineering and Adventure"
By R. B. McDONALD



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 84 — NEW YORK, THURSDAY, JANUARY 1, 1920 — Number

"Engineering News-Record" is a consolidation of "Engineering News" and "Engineering Record," effected in 1917.

"Engineering News" was founded in 1874 by George H. Frost, as the "Engineer and Surveyor," which title subsequently became the "Engineer, Architect and Surveyor," then "Engineering News and American Railway Journal" and finally, "Engineering News," under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

"Engineering Record" was established in 1877 by Henry C. Meyer as the "Plumber and Sanitary Engineer." The name was subsequently changed to the "Sanitary Engineer," "Engineering and Building Record" and, finally, to "Engineering Record." During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The staff of "Engineering News-Record" consists of

E. J. Mehren, *Editor*
R. K. Tomlin, Jr., *Managing Editor*
M. N. Baker — H. H. French
F. E. Schmitt — J. W. Shaver
F. C. Wight — G. A. N. Thall
Charles Whiting Baker, *Consulting Editor*
Chicago: W. W. DeBerard, E. E. R. Tratman, C. S. Hill
San Francisco: N. A. Bowers

Returning the Railroads

BY HIS proclamation of Dec. 24 ordering the return of the railroads Mar. 1 of this year, the President has swept away the cloud of uncertainty that enveloped the situation because of the failure of Congress to enact adequate legislation before Jan. 1, 1920. Under existing circumstances, the return of the properties now would result in serious complications. The way has been cleared for Congress to complete the difficult task of reconciling the differences in two vitally different measures upon which we comment elsewhere.

The Industrial Situation

AN EXTENDED review of the industrial situation is not warranted at the present time. The facts stand out too clearly to make comment necessary. We are painfully aware that the year has been unprecedented in the number and seriousness of labor difficulties. It is equally clear that the situation is decidedly better now than at any time since the armistice was signed. The coal difficulty, it is true, is still with us, and the probabilities are that we have ahead the necessity of adjusting a railroad-labor situation. But, by and large, there is a greater degree of sanity on the labor question than there was at the beginning of the year or in midsummer. We have proved some things to ourselves. We have demonstrated that the country stands for order, not anarchy. We have learned that the vast majority of the workers believe in improving the present order of society rather than in upsetting it and experimenting with a soviet regime. We have shown that in an issue between order and anarchy the people will make any sacrifices that order may triumph. At Boston the National Guard willingly assumed policing duty and thousands volunteered to serve in any capacity needed to maintain the law. In Kansas all classes flocked to the coal mines at the Governor's call. All of this helps to stabilize conditions. The nation has served notice on the reds that we will have no part with them. The demonstration of the public's position has encouraged the sane men in union labor ranks, and progressively saner handling of their problems can be expected there. In general, conditions are hopeful. We look forward toward improving conditions.

1919 in Engineering

SPEAKING generally, the year 1919 will go down in engineering history as one of inaction. Due to the inertia in recovering from the war's dislocation, to shortage of labor and materials and to high prices, all branches of civil engineering were subnormal except that of highway building. Toward the mid-year plans for municipal facilities and housing began to be developed vigorously, but the development did not start early enough in the year to come into the prominence that was accorded highway work. The latter occupied the center of the construction stage, though it, too, suffered curtailment because of the late letting of contracts and the shortage of both materials and labor. Aside from the vigor shown in the highway field, the foremost engineering problem was the disposition of the railways. True, the chief matters at issue are, in the broad sense, political, but their engineering interest is paramount because their solution will determine the policies governing railway expenditures. In nontechnical matters, interest centered upon the engineering societies' problem. The various development and aims and organization committees of the founder societies rendered their reports during the year, and all of them combined in a joint conference report looking to more effective federation by engineering societies. The American Society of Mechanical Engineers has received and approved the report of its aims and organization committee and of the joint conference committee, and this stands as the sole definite action. As in technical activities the year lacked fruitfulness, so did it also in engineering-society affairs. The year was one of adjustment, of settling down, of clarification of views, rather than of action.

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The Coming Year

IN CONTRAST with the relative inaction of 1919, the year 1920 should be a busy one, the limits of activity being set by available supplies of materials and labor and, possibly, by prices. One cannot say that there is a spirit of optimism abroad—or of pessimism, either. It is, rather, a settled determination to go ahead despite conditions.

There are reasons enough to deter the timid. The industrial situation is not yet stable, though it has measurably improved. It was difficult to get materials during the latter part of 1919, and the shortage of railway cars, responsible for the curtailment, will be even worse in 1920. Prices are high; they may go higher, though we hope the peak has been reached. Our present inflation may end in collapse, while a presidential election year has often been given as the reason for proceeding cautiously.

Despite all these possibly adverse conditions, we look forward to a bigger year than the one just closed. In the work held back since the spring of 1917 there is a large volume that the projectors consider cannot be deferred longer, provided costs do not go higher. This is true, among other lines, of highway construction and of a goodly volume of municipal work.

As to labor, there is ground for expecting that, with greater distance from the war's excitement, we shall get greater efficiency. The use of machinery has increased materially in recent years, and it should be used even more widely in 1920. While, therefore, we shall undoubtedly find that the amount of work accomplished in 1920 will be dependent on the number of men that can be obtained, we may expect the work to be in larger volume than would be predicated on the performance in the latter half of 1919.

Labor shortage, of course, affects materials supply, but the limit there was set last year not by the labor available, but by the lack of railroad cars. Steps are being taken by highway officials to make their work less dependent upon rail transportation this year, and, if successful, their efforts should make a larger percentage of supply from existing commercial gravel and crushed-stone plants available for other construction operations.

High prices undoubtedly held back much work last year, particularly in the early part of the season. If prices hold where they now are, the price-factor will not be a serious deterrent this year; enough work will be offered to tax the materials and labor supplies to the utmost. Certainly, no considerable reduction in prices can be looked for. Demand will outstrip supply, with the inevitable tendency to force up prices. On the other hand, producers of materials realize the danger of curtailment should prices go higher, and will do all in their power to prevent a runaway market. The control of the situation, though, lies actually with owners and contractors. If they lose their heads and bid against each other beyond reason, nothing will be able to prevent sharp advances. In some quarters there is now evidence of a slowing up in the launching of new work—a slackening of the boom that appeared to be on the point of getting under way in the summer.

All things considered, however, the indications point to a busy year.

Progress in Licensing

FOUR states enacted license laws for engineers in 1919—Oregon, Colorado, Iowa and Michigan. This puts laws regulating the practice of engineering on the statute books of nearly one-quarter of the states of the Union, an indication that the movement is gaining headway fast. In none of the states have the laws with the more modern provisions been in force long enough to admit of experience, although an opinion from a prominent engineer-educator in Florida, which in 1917 adopted a law founded on the original suggestions of the American Society of Civil Engineers, is that engineers of the state are unanimous in thinking that the law is vastly better than the absence of one, but that it needs some revision.

Engineers in Ohio and Indiana have made efforts to secure laws, and probably at coming sessions results will be obtained. Other features in the movements are the drafting of a model licensing law by the American Institute of Architects, and another by a committee of Engineering Council. Two national bodies, the American Association of Engineers and the American Institute of Architects, have gone on record as favoring licensing.

Opinion on the justification for licensing is crystalizing definitely along the one tenable line, that of public benefit—protection of life, health and property. While there are direct benefits to the profession, they are generally regarded as subordinate.

Present opinion is that the law should be brief, should give much discretion to high-caliber examining boards, and stress educational qualifications and moral fitness.

A citizenship qualification is receiving more serious consideration than at first, while reciprocity features are made as nonhampering as possible, so that nothing will prevent projects attracting the best talent.

Opinion so far expressed in the states having laws is favorable rather than otherwise. With no counter-wind blowing, it may be expected that the licensing movement will continue to gather force in 1920 and that the year will see new laws put on the statute books.

The Year in Engineering Education

ENGINEERING education, like most other activities, was the subject of much discussion a year ago. The school regime had been interrupted by the Students' Army Training Corps, and that had been preceded by the publication of Dr. Mann's report on engineering education. Within the colleges there was, as a result, questioning of the desirability of change; while on the outside was a strong feeling, confidently expressed, that this was not only an opportune time for introducing innovations in the engineering courses, but that engineering curricula were in need of revamping.

Now the year has passed. What has been the result of the ferment? On the whole, there have been few changes, but such as have been made are indicative of an attitude that promises future developments. These changes, too, show the influence of the Mann report and the S. A. T. C. experience.

In a number of schools, an effort is being made to

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introduce engineering subjects in the sophomore year, and thus at an earlier period give the student some notion of that with which his life is to be concerned. At the University of Minnesota, for example, in the sophomore year, there is now being taught a combination course in mathematics and mechanics, having this object in view. In several schools new courses in economics are being introduced, not in the dry-as-dust fashion of the liberal arts college, but as an adjunct of engineering problems. In other institutions, notably at Iowa State College, the "Camp Humphreys idea" is being tried. The attention of the student is directed in an engineering way to structures with which he has long been familiar. He is taught to see them in the new light, with the purpose of stimulating his interest and getting him to realize the character of the problem that he must encounter in practice. At the University of Cincinnati, at Yale, and at a number of other schools, stress is being placed upon labor relations. In several institutions, English for engineering students is being placed on a better basis and is being made the vehicle for broadening the student's grasp of history and economics.

The experiments are scattered and in their infancy. Such as they are, however, they seem to reflect the stimulus of the Mann report. The impress is deep enough to warrant the expectation of further developments. Should the effort to interest the student at an earlier period in engineering problems succeed to the extent of causing him to bring fresh energy to his work, the influence of the new methods will be a broad one.

One of the lessons which might have been drawn from the S. A. T. C. experience and from the methods developed in training mechanicians during the war has apparently made no impression. We refer to the possibility of instituting short courses—say of two years—in engineering, with the purpose of supplying the heavy demand for men to fill the lower professional ranks. The S. A. T. C. and mechanicians' courses certainly did show how intensive work could be given. Apparently, however, the teachers of engineering believe that they have no function or responsibility in trying to supply the demand for inspectors, junior draftsmen, etc. We cannot find that serious thought has been given to the subject by the engineering colleges, but to us such thinking would seem a natural consequence of the war-time intensive training experience. Possibly the failure of the S. A. T. C. may have discouraged thinking along these lines. That failure, however, was due to administrative difficulties rather than to the ideas underlying the non-military side of the work.

In general, then, while the year brought forth no great number of changes in engineering curricula, and possibly while we ought to be glad that the conservatism of the past has prevented us from being carried off our feet with ill-considered innovations, it is nevertheless true that there are certain encouraging signs. Going back to his own engineering course, practically every engineer will admit that his interest would have been heightened if there had been a live approach to the problems he was expected to meet in after life. The experience of the year 1919 indicates that some engineering teachers are considering methods of presenting problems in that spirit, and the indications are sufficient to warrant us in looking forward to solid results.

The Precarious Position of Engineering

THERE has been an unusual amount of activity in the year just passed regarding the compensation of engineers. Data have been gathered and compiled in an effective way, and salary recommendations prepared taking cognizance of the engineer's responsibility and of the shrunken value of the dollar.

The new activity has been due to the urge of the increased cost of living, which has been particularly hard upon the salaried class. Very few, however, even of those active in the recent efforts have appreciated thoroughly the seriousness of the situation. We say, without fear of contradiction, that the effects of the present inadequate salary scales will be far more serious to the public than to the engineer. The engineer can protect himself by leaving the profession, which he is doing in large numbers, but the public must bear with such engineering talent as will remain.

Every engineer knows that there is an alarmingly rapid drift out of engineering into commercial pursuits. The seriousness of this drift will be more evident if we give some consideration to the economic situation in which we find ourselves. In every branch of engineering we are at least three years in arrears in construction. War-time restrictions and shortage of labor and materials have prevented the normal amount of construction since the spring of 1917. There is a shortage of housing everywhere, and a shortage of housing necessarily is accompanied by shortage of all of the tributary urban facilities, such as water-supply, sewerage, paving, electric light and telephone service, urban railway transportation, etc.

In addition to the huge task of catching up on housing and municipal facilities, we have a far more urgent problem in highways. Their demand on the profession will alone be tremendous. According to the United States Bureau of Public Roads in 1920 there will be available for expenditure on construction $633,000,000, more than four times as much as has been available in the largest previous construction year. Right now the highway organizations are inadequately staffed, both in size and ability, for the tremendous program in hand. The difficulty is exactly that which befell our war-making agencies in 1917. Overnight they were obliged to increase their size threefold, fourfold, tenfold. Just that is happening in highway work. Except for the State of New York, the programs have been moderate. and the organizations of relatively small size. Upon such organizations, attuned to doing say $2,000,000 or $3,000,000 worth of work a season, have now been thrust $50,000,000 and $60,000,000 bond issues. All of this money is not available for expenditure in one year, but one state hopes to be able to put as much as $32,000,000 worth of work under contract for the next season. It paid out $10,000,000 last year and will probably pay out $25,000,000 in 1920. These are startlingly large sums, and while they represent one of the heaviest programs, $5,000,000 programs will be common this year.

Yet with these expenditures facing the profession, we find salaries so inadequate that there is an alarming desertion from the ranks. Men intrusted with the expenditure of millions get salaries of $5000 a year and less. In fact, the salaries above $5000 in public service

are infrequent. Unless these salaries are raised, we shall not be able to hold men who can put these programs through with credit. Here and there self-sacrificing men will stay, but, by and large, the salaries must be made somewhat nearly adequate to the responsibility, in order to hold good men. The salaries of subordinates are even less commensurate with their responsibilities, and the difficulty of holding competent men proportionately greater.

If the present conditions persist—low salaries, and consequent desertion from professional ranks—there is certainty of disaster and serious reflection upon the engineering profession. There will be brought about an inefficient expenditure of public funds. Engineers will protect themselves by going into other and more lucrative pursuits. The public will be the sufferer.

We hold, therefore, that it is incumbent upon engineers as individuals, upon local engineering societies, and upon the national bodies, to concern themselves most seriously with the problem of engineers' compensation. In taking up the fight they should make no apology. The interests of the public are seriously at stake.

The Year in Society Affairs

THE beginning of the year 1919 found the engineering profession intensely interested in a study of the purposes of its societies. There was a feeling that the war had created new conditions of which cognizance had to be taken by changes in society ideals and organization.

Contrasted with the attitude, then, the interest in society affairs has waned very much. We take it that the average engineer has become engrossed with reëstablishing himself and with the largeness of the problems propounded by the reconstruction era.

Nevertheless, the year has brought a clarification of views regarding some of the society problems that have been confronting us. The reports of the various aims and development committees of the four founder societies have in only one case, as we read them, got down to anything of a fundamental nature, and that is the report of the development committee of the American Society of Civil Engineers. That document proposes changes in organization which correspond, in the main, to demands that have been growing for years. All of the reports agree in this, that the national technical societies should confine themselves to technical work, and that civic and welfare activities should be intrusted to a separate organization. This recommendation is accompanied by a recognition that the national technical societies cannot divest themselves of responsibility for the general welfare of the profession, and all of them provide, through concurrence in the Joint Conference Committee's report, for participation by the founder societies in a separate body whose sole function shall be public and welfare work.

The chief interest in society affairs now centers upon a method by which engineers shall look after their own welfare and have an influence upon civic questions of an engineering character. We have expressed the view that Engineering Council has failed to fasten itself upon the sympathies of the engineers of this country. We see no reason to change that view; the Joint Conference report is an expression of the same idea.

The Joint Conference Committee report proposes a substitute for the council, differing from the present body in that it will allow representation of local societies. While this should help the federated body to grasp the local needs of engineers, there is no expression of those needs in the report. There is no denying that Engineering Council has done some good things, but most of its activities have been on large problems in which the individual engineer has no personal interest. For example, its most ambitious endeavor—its coöperation in the efforts to establish a Department of Public Works—while a notable and laudable object, has not that personal appeal which will secure a large following. Its licensing and compensation activities, on the other hand, are of the type that awaken personal interest. The purposes set up for the federation in the Joint Conference Committee report partake chiefly of the general rather than of the intimate character.

The point of view needed, in our judgment, is that the federation should become a clearing house through which aid can be extended to the local societies. Take, for example, the matter of legislation. Every year sees a flood of state bills that affect engineers and engineering. A clearing house could collect and compare these measures and send to the local societies information on similar legislation—its success or failure—elsewhere. Such a handling of intersociety relations would make in each locality a host of supporters for the federation.

One development of the year stands out as notable—the increase in membership and in effective activity of the American Association of Engineers. Starting the year with less than 3000 members, it ended it with more than 10,000. Its organization work has been no less vigorous than its membership increase. It has dotted the country with chapters and clubs and has been successful in getting these bodies to work. While Engineering Council joined with the association in presenting to the Railroad Administration proposed new scales of salaries for engineers in railroad service, it has been the association and not Engineering Council that has secured the results. It initiated the movement in its conference of railroad engineers in Chicago in March, and through the organization of local bodies in railroad centers has effectively presented the matter to the regional directors. With equal activity it is now attacking licensing and the compensation of highway engineers and again will try to get results, not through headquarters communications, but by action of its subsidiary bodies. By its energy it has risen in a year's time from a relatively inconspicuous organization to one that must be reckoned with in the engineering-society activities of the country.

As to another feature of last year's activities—the union movement—a brief word is needed. Making rapid progress in the early part of the year, the impetus seems to have died down since summer. The locals are holding their own in some sections, but nowhere does there seem to be enthusiasm. This result was to be expected. As conditions become stabilized and compensations are adjusted, the union movement can be relied upon to pass entirely out of engineering ranks. Its views are entirely at variance with the normal thinking of engineers and will have no

permanent hold on the sympathies of even the younger men. In special cases strength may be expected, but there is no possibility of large permanent development.

Where, then, do we stand today in engineering-society activities?

The fever of the early part of the year has gone, and a pretty sane type of thinking can be relied upon in connection with the proposed reorganizations of existing societies and the formation of a federated body. Radical innovations will not come. That which is fundamental in the various recommendations must, however, prevail. Failure to act promptly will merely prolong discussion and agitation until the needful changes are brought about. We are in hope that the principal recommendations of the report of the development committee of the American Society of Civil Engineers—those relating to district organizations and to the strengthening of the technical work of the society—will prevail, and that there will be effected a federation of engineering societies based on the fundamental idea of working as a clearing house or an agency for the locals. Such a federation will still handle the large national problems, but its strength and support would come because of its hold on the individual engineer through the service it would render him by coöperation with his local society.

Highway Construction in 1919 and Its Lessons for 1920

ROAD construction in 1919 was characterized by the extensive employment of large contracting organizations, and by the intensive use of construction machinery. These factors, which should have made for the construction of a large mileage, were offset by adverse factors, so that the programs lagged behind schedule. These adverse factors were an acute shortage of materials, a late start of work and unsatisfactory labor conditions.

While the available statistics are scant, they indicate the situation clearly. In 1916, the year of greatest highway activity, $136,000,000 was expended for paved-road construction. Precise values have not yet been determined for 1919, but in round figures the construction completed aggregated $138,000,000. There was under contract in 1919 work estimated to cost $165,000,000 which was not completed and which has been carried over into 1920. No estimates, even in round figures, are possible of the value of the equipment employed, nor of the number of construction organizations engaged in 1919 compared with previous years, but general observation testifies that both have been vastly greater.

Why has highway construction lagged? An answer to this question is the most important service which a review of the year 1919 can render, because, for every mile of highway under contract in 1919 it is planned to place two miles under contract in 1920. Two-thirds of a billion dollars are available to pay for paved-road construction during the new year. Should there be continuation of the conditions which have caused construction to lag in 1919, there is no hope of finishing the larger program contemplated for 1920. In fact, we may as well admit that even with the best of conditions, we cannot spend the money available for 1920.

With excellent success in securing contractors in 1919, less than half of the mileage which was under contract has been built. Late letting of contracts, shortage of materials and adverse labor conditions all tended to this result.

Contracts generally were awarded late in the season. A decided improvement was accomplished by letting large-mileage contracts, but these, due to their very size, involved delay the first season because of the longer time required to organize and to assemble plants.

Another cause of delay arising from contract conditions has been experimentation with new methods and equipment. Many general contractors, whose operations have normally been in other fields of construction, engaged in road work for the first time in 1919. Having no experience of their own, and the field lacking standardized practice, these contractors were encouraged to experiment in methods and machinery. No new methods is fully successful at the first attempt, and while development is proceeding construction lags.

Acute shortage of construction materials, and particularly of sand, gravel and broken stone, was the main cause of delay. Several circumstances were responsible for the shortage. Lack of railway cars and the ranking of the shipment of road materials as secondary to other traffic demands unquestionably headed the list. Contributing to the difficulty, however, were the crowding of producers in certain localities, which resulted in shipments that could not pass inspection, and a frequent grouping of operations so as to concentrate demands on a few producers, and on a single railway line.

Naturally, efforts were made to overcome the difficulties, but with small success. The most hopeful line of effort is in the direction of developing local material supplies at the roadside or within trucking or industrial-railway haul. This development is due to the fact that railway-car shortage was the chief element in causing materials shortage.

At the close of the season, a new development appeared in connection with materials supply which contains the elements of contention—an obvious and general swing toward state control of materials. Simultaneously contractors took a stand unqualifiedly in favor of complete control by the contractor of the purchase and shipment of materials. Without weighing these opposite ideas, the circumstances command attention because they involve the relationship of the large construction organization and the road officials in developing future road-construction programs.

Labor conditions as a factor in the lagging road construction program of 1919 reached beyond the supply of workmen to the supply of contractors and of engineers. There was a deficiency of workmen, and they were inefficient and unstable in the high degree characteristic of the times. Perhaps on the whole, because of the extensive substitution of machinery, the men in the construction gang contributed less to the year's lagging program than did unqualified contractors.

Analysis of the causes which have been cited as responsible for delayed progress in the highway-construction progam of 1919 is encouraging, because of the clarity with which it discloses that the causes are either temporary or can be largely eliminated by highway officials, except possibly as to materials. Upon car shortage must fall the responsibility for the shortage in paved roads completed last year, and to it, unless cor-

rective measures are enforced, will have to be charged the failure to realize the construction plans of this year, where local supplies are not available.

New Concrete Proportioning Theories Put Into Practice

ANOTHER and most important chapter in the current studies of new methods of proportioning concrete is added by the paper by R. B. Young on p. 33 of this issue. Engineers who were only confused by the earlier discussions of water-cement ratio, fineness-modulus and surface area, and who were disposed to consider the whole matter highly academic, will begin to feel on more sure ground when they read of actual construction, ultimately to total a half-million yards of concrete, in which the concrete is proportioned not in the time-honored volumetric relation but according to quantities determined by desired strengths and the dimensional qualities of the aggregate. Further than that, there is every promise that the work of the laboratory experts will have a definite and salutary effect on the worrisome subject of wet or dry concrete.

Following the introduction of the chute method of placing concrete, and with the spread of reinforced concrete with its narrow forms and impeding steel, the early standards of a dry mix went by the board, and wetter and wetter mixtures became prevalent. Many warnings were given of the danger of this practice, but it was not until about two years ago that the quantitative effect of too much water was pointed out by Professor Abrams. At that time he laid down the principle that within the limits of practical aggregate and workability the strength of concrete is a function of the water-cement ratio in the mix. The practical application of such a principle hinged on the question of workability, and this he decided was a function of the grading of the aggregate, which he measured by a sieve-analysis constant known as the "fineness modulus." About the same time L. N. Edwards arrived at somewhat similar conclusions, except that he related the workability to the surface area of the aggregate.

Encouraged by these theories and the tests which led up to them, a number of engineers, who had been opposed to the prevalent wet mixes, established on their work requirements for dry concrete, and for lack of a better measure of workability specified a "slump" test which in various forms had been used in the different laboratories. According to this, all concrete had to take a certain minimum slump when released from a confining mold. The proportioning was still volumetric, except for the water, which was gaged by the results of the test. The most notable instance of such a specification was on the Illinois roads, and there it has not proved practicable. The tests prescribed almost invariably resulted in so dry a concrete that its workability was impossible, with the result that water was added according to ideas of foremen accustomed to the old, sloppy mix.

It appears, therefore, that a test which may indicate an optimum workability and a proper cement-water ratio in the laboratory is not adaptable to the varying conditions of the field. Here, then, is where Mr. Young's studies are a step forward, for he has decided that it is not necessary quantitatively to test field workability, since, according to the Abrams principle, which he considers his tests to have confirmed, water-cement ratio controls strength within the ranges of any practicable workability. It is only necessary, therefore, to establish that ratio for standard or normal laboratory consistency, and then to use it in the field, always remembering that it is the ratio of the water to the cement which must remain constant.

In other words, instead of following the customary practice of controlling workability by gaging the water alone, on the work of the Ontario Hydro-electric Power Commission a proper or desired consistency is attained by adding or subtracting *both* water and cement in the proportions established by laboratory and field tests of the aggregate to produce a concrete of the desired strength. The absurd reduction of such a practice would lead on the one hand to no cement paste at all, and on the other to aggregate scattered widely through a great mass of cement paste; but here the Edwards theory of surface-area control of workability, also confirmed by Mr. Young's tests, comes into play. For any given aggregate the field workability is confined in a fairly narrow range by the ability of the cement paste to cover the surface of the aggregate. So long as the cement-water ratio is correct, a consistency satisfactory to a practiced concrete worker will attain the desired strength.

Engineers will recognize the great advantages of such a method of proportioning, provided the theories on which it is based are proved correct. Once having ascertained the constants of an aggregate being used on a job, the quantities of aggregate or of cement and water, whichever is the more simple to control, can be fixed as to delivery to the mixer, and the consistency of the concrete varied almost from batch to batch by the simple changing of the variable ingredient, with the assurance that the resulting concrete will have constant strength. The troubles with the question of wet or dry concrete will be over.

It is not to be assumed, however, that such a millenial day for concrete has unquestionably arrived. There is still much controversy among testing specialists concerning the invariability of the water-cement law, and the crucial determination of a normal consistency is yet to be assured. As to the former, it seems to be the Bureau of Standards against the field, with the indications that within the fairly narrow limits of practicable aggregate grading the law holds. A number of laboratories are conducting tests which should give valuable information in a short time. Normal consistency for the "Hydro" tests is determined largely by eye, but Mr. Young states in his article that he thinks they are on the track of a quantitative determination. Something more consistent than the slump test must be found.

The scheme will work only when other principles of good concreting are followed. It does not relieve the builder of the necessity for having good, clean aggregate and water, of thoroughly mixing the concrete and of providing proper cement. Furthermore, it involves considerable laboratory and field investigation where skill and experience are required in high degree. However, if it furnishes a consistently strong concrete with a saving in cement and settles the water-content problem its general adoption is only a matter of time.

Railroad Legislation

NOW that the President has proclaimed the return of the railroads to their owners Mar. 1, 1920, there is more urgent need than ever for the enactment of an adequate law governing the regulation of the roads. Return on Jan. 1, 1920, as the President had contemplated, would have been followed by serious consequences. With the passage of the Cummins bill in the Senate Dec. 20, the House and Senate will begin to thrash out the differences in their respective measures. The differences are so great that delay would be almost certain were not the situation so urgent.

The Cummins bill bears evidence of a desire to grapple honestly and broadly with a difficult problem. On the whole, the measure presents a better basis upon which to work out a settlement than the Esch bill, passed by the House at the last session, because it recognizes the need of a better adjusted Federal regulation and a more definite plan of ratemaking. Assuming that private ownership and operation will continue, these are the two most important elements of the case. But we doubt that its labor provisions and the limitation of "excess" earnings by a diminishing proportion allowed the carrier would meet with ultimate success.

The Cummins provision creating a Federal Transportation Board, charged with the administration of various operating functions, hitherto thrust upon the overburdened Interstate Commerce Commission, is a step forward. Unfortunately, the Esch bill fails to recognize the need of some kind of Governmental *operating* body, charged with maintaining the efficiency of the transportation machine, as well as a *judicial* body endowed with regulative powers. True, the House bill contains commendable features designed to overcome difficulties by broadening the powers of the Interstate Commerce Commission in operating matters, but it is essentially a move to revert to the old status, with the Commission in complete control and furnished, on ratemaking, only with the old mandate that rates shall be "just and reasonable." The Commission is now so overburdened that it has not been able properly to discharge its present operating functions.

The Cummins bill faces the rate question more squarely than the Esch bill, with the command to the Commission that rates shall in general be made to produce definite returns. But it is to be regretted that both bills do not restrain state commissions from interference in rate matters. The Senate bill, however, wisely provides for Federal incorporation, which would bring about better regulation of finances and eliminate some of the conflicting features of state control.

As to wage disputes, the Esch bill is wholly inadequate in its failure to provide any definite method of adjustment and to recognize, in the make-up of its two labor boards, the great bodies of unorganized railroad employees. In general, public sentiment is inclining toward a stricter handling of the railroad-labor problem, and the Cummins provisions forbidding strikes will get wide support, in the belief that the community has the right to safeguard essential services. In the case of such services as the police, fire-protection and water-supply forces, the need of anti-strike laws is imperative. But there is at least room for doubt that the railroads are in the same category. The opinion is not at all uncommon that a general railroad strike would break down very quickly, with the public the victors. While we favor a strong policy, we believe that from the standpoint of expediency a plan forbidding strikes while the difficulties are under arbitration and allowing, say, three months for negotiations, would have a better chance of success.

It is generally agreed that consolidations of present companies are, within certain limits, desirable, but the Senate provision for making mergers compulsory at the end of seven years will be strenuously opposed by many of the strong companies, previously enjoying more than average prosperity through strategic geographical position. The weak roads will, in general, welcome it. The probability of long litigation should be considered. In this respect the Esch bill is the better, merely extending power to the Interstate Commerce Commission to approve mergers in the public interest.

The greatest objection to the Cummins bill is in the method imposed for restricting net earnings by taking from the companies a rapidly increasing proportion of the net, and its failure more clearly to define "value" as the basis of the 5½ per cent return upon which rates are to be determined. Public sentiment is set upon restriction of net profits of public utilities, but the method proposed gives insufficient recognition to efficiency and ability of management. Value, unsatisfactorily defined in the act, must, in so far as possible, be clearly set down in any measure contemplating fixed rates of return. Moreover, the rates of return, instead of being fixed, would better be made variable on new capital, subject to change at stated intervals and based upon actual conditions of the money market as determined by the Federal Reserve Board or other impartial body. Only in this way can the companies be *assured* of new capital for needed betterments.

In providing for the transition from Government to private operation, both measures temporarily guarantee incomes—the Esch bill for six months with a "revolving fund" of $250,000,000, and the Cummins bill for five months with a similar fund of $500,000,000. But the Esch bill as amended by the House provides that amounts due from the Government as rental shall be set off against amounts advanced by the Government for capital account, funding any additional indebtedness of the carrier at 6 per cent with the principal payable upon demand in five years. Such an arrangement would certainly impose a heavy burden upon the credit of companies without great financial strength.

To hasten agreement between the two branches of Congress, we hope that the President will transmit his promised message on the railroads as soon as Congress reconvenes after the holiday recess. The prospect now is brighter than ever for a successful settlement of the problem. While the undoubted influence of a highly organized and persistent propaganda for the Plumb plan must be considered, the Senate vote of 65 to 11 (just before the passage of the Cummins bill) against the La Follette measure for extending Federal control for two years is significant as well as gratifying. Although the rules of conference, if strictly adhered to, will prevent the addition of new features, we look forward to a report that will embody the best portions of both bills and result in the passage of a final law better than either.

Developments in 1919 in the Use of Machinery for Highway Construction

Progress Made in Determining Types of Plant Adapted to Rapid and Economical Construction—Use of Motor Trucks and Tractor-Trailers for Material Haulage Increases

By C. S. Hill
Associate Editor, *Engineering News-Record*

MACHINERY was more widely employed last year and in larger plant units than ever before in highway construction. Due to experimentation, unskilled direction and lack of experience in selecting plant, the results were not definite. Toward the end of the season, certain general conclusions began to be drawn. Experience had indicated which types and arrangement of equipment gave the better results. Nevertheless, highway builders will not find in the year's experience a definite answer to any specific question, not even to the question whether extensive machine equipment is wise.

The season, however, did advance highway construction plant practice in one respect: it pointed out the need for most careful coördination between the various items of plant, the introduction of the factory idea. In other words, it directed attention to the plant as a whole, rather than to individual machines or items of equipment. In addition, it helped to establish a broad classification for types of highway plant; it emphasized the importance of skilled direction of operation, and showed up weakness in plant design.

Broad Lessons Learned

In general, the chief advance of the year was the emphasis, above referred to, on the development of complete road-building plants. There was little new in the development of machines as such. The power finishing machine, which came nearest being new, was old, though not previously widely used, and so were other devices that in the last year were generally considered novelties.

Despite the fact that the chief advance of the year was in the direction of properly coördinated plant, the impression must not be given that there was universal appreciation of the idea. There was progress, however, in getting it accepted, and this progress was due to two circumstances: The adoption of large-mileage contracts and the extensive entrance into the field of large general construction companies. The large contract provided the opportunity and, perhaps, the need, and the large contractor possessed the necessary capital.

Progress during the year in determining the best types of plant, like the progress in the coördinated-plant idea, was partial. Four general types were used:

1. First in order of use and in the perfection with which the details had been worked out, was industrial-railway haulage of batches loaded at a central proportioning plant and charged directly to mixers traveling the subgrade.
2. Stationary mixing plants with long-distance haulage of wet concrete onto the subgrade.
3. Portable mixing plants, moved to widely spaced stock piles in succession, with short-distance wet haulage onto the subgrade.
4. The long-familiar paving-mixer outfit charged by wheeling from continuous stock piles on the subgrade.

Classified according to the magnitude of the operation, the first type led, followed closely by the third type; these were the popular plants for large operations of 10 to 20 miles of road, and were in general use for smaller operations also. Generally, the second and fourth types were confined to contracts of about five miles and never to those exceeding 10 miles.

Classified according to magnitude of investment, the first type of plant led in cost, with the second and third types close seconds and the fourth type well in the rear. Classified according to the number of units and the necessity for their close coördination, the types ranked about in the order in which they have been numbered. Classified according to general utility of the equipment, the order was about as follows: The first type of plant had the fewest major units which were suited to other operations than highway construction, the fourth type followed, the third type came next, and the second type had the greatest number of units which could be used for general construction.

Based on last year's records, which is unfair for reasons which are indicated further on, none of these plant units demonstrated great superiority over the others in average output for a season.

Large Versus Small Plants

The fact that under last year's conditions the small outfit suffered so little in comparison of output with that of the large plants, draws attention to the need for skilled management. Let it be clearly understood that in thus comparing outputs of small and of large plants, the latter exhibited much greater *rates* of output, but little, if any, greater *averages*. Better management of the smaller plants was possible under the conditions of acute materials shortage. They could be operated to full capacity when the large plant could not. They could be operated at part capacity at less cost per unit of production. This did not prove that the large plant was inferior; it merely demonstrated that large-plant conditions were necessary for successful large-plant operation.

In emphasizing the conditions required for the use of large plants, last year's experience performed its greatest service to the contractor. These requirements are:

1. Materials supply always equal to the output capacity.
2. Exact coördination of plant units in speed and capacity.
3. Precise routing of materials on the work.
4. Rigid maintenance of all machines in working order.
5. Planning ahead of operations, and
6. Complete recording and analysis of methods and results.

Experience last year, furthermore, made plain the fact that unless these conditions are assured, large-plant construction outfits will fall short of their possibilities and may prove unwise.

To recapitulate, the year's far-reaching developments in machine construction of highways were: Extension

of the practice of the factory idea of coördinated equipment; broad definition of successful plant types, and emphasis on the importance of skilled direction of plant operations.

New Machines and Operations

Strictly speaking, no new road-building machines were developed. Several were new in the sense that they were generally used for the first time last year. Outstanding among these is the power compacting and finishing machine for concrete slabs. For quick reference, the machine development of the year may be considered under: Grading and subgrade preparation; unloading and proportioning of materials; transportation of materials; charging materials and mixing; placing and finishing pavement.

In heavy grading, tractor operation of plows, scarifiers, and grading machines was noticeably increased. The development of a definite practice of substituting tractors for horses in all operations requiring more than one team appeared. With tractor operation an indication also was had of the need for strengthening machines for uprooting and cutting down hard packed material like old macadam and gravel surfacing. For light grading or subgrade preparation there was an increased use of machines for fine finishing in order to meet the growing tendency of specifications to call for profiles exceedingly close to theoretical lines and surfaces. In some specifications ½ in. was the variation permitted. In design of novelty, the subgrade finisher or planing machine stood out most prominently. This machine rides on steel side forms set ahead accurately for slab construction, and is hauled by a road roller or tractor. With skilled operation, the fresno scraper was another successfully used device for close finishing.

Loading-plant practice in 1919 indicated that the ideas of contractors were still rather jumbled. Stationary elevator bins, traveling bins, and stock piles over tunnels, both surface and subsurface, were used about equally, with both locomotive cranes and derricks, and both large and small buckets for unloading. Toward the end of the year, favor leaned to the elevated bin plant. A growing inclination toward traveling bins as advantageous in cutting down switching and shunting operations was also apparent. Bulk handling of cement was the successful loading-plant experiment of the year. The experience of several contractors demonstrated the practicability of (1) safe shipment in open-top cars with tarpaulin covers; (2) unloading without waste by clamshell buckets; (3) storage in open-top bins with tarpaulin covers; (4) charging by measuring chutes without excessive dusting. Careful planning of material-handling appliances is sufficient to make the use of bulk cement entirely practicable in highway construction, with a consequent material saving, if the limited experience of the year is a safe criterion.

Job Transportation of Materials

Job transportation of materials was demonstrated anew by the year's experience to be the crucial task of modern paved-road construction. There were three types of haulage operations: (1) Haulage of raw materials to stock piles in the grade; (2) of dry batch from loading plant to mixer; and (3) wet batch from mixing plant to subgrade. Each of the three operations presented its special problem.

Increased use of motor trucks and of tractors with trailers was the year's new development in hauling material to stock pile on the grade. Success was dependent upon road conditions. Dirt roads in wet weather put the large-load, heavier vehicles virtually out of commission through reduced speed, even when the machines were not stalled. This led, as experience was gained, to the use of lighter trucks. The question whether light trucks, through greater ability to travel soft roads, might not increase the number of trips sufficiently to excel in haulage performance the larger, though slower, heavy trucks, was raised by the year's experience.

Dry-batch haulage to the mixer from a central loading plant, through the use of industrial-railway plant, was general. Gasoline locomotives were the motive power. Batches were carried in boxes on flat-cars or in car bodies removable from the trucks. In detail, the approach to a standard was not so close. Weight of locomotive and of truck, length of trains and size of batches, showed a great variation. The manifest haul was, however, less a lack of uniformity than one of capacity. To operate the modern three-bag batch or larger mixer at full capacity, greater speed was found necessary in carrying materials, and a demand for heavier equipment developed—for six-ton in place of three-ton locomotives; for 25-lb. instead of 20-lb. rail; for 20-car to 30-car trains instead of 10-car to 20-car trains; and for 15-mile speeds instead of eight-mile speeds.

Realization of the vital importance of thoroughly equipped industrial-railway plant, and its efficient operation, was the outstanding feature of the year. As employed on fast road work, the industrial railway is in miniature a modern commercial railway with intensive traffic. Train schedules, train loads, running speed, accident prevention and maintenance are essentials that must be planned, and the plan must be flexible to meet emergencies. The job of traffic manager is a position which this year's experience with industrial-railway haulage has raised to prime importance.

Wet-Batch Haulage Possible

Wet-batch haulage was demonstrated by the year's operations to be an important possibility. Two means of transportation were successful—motor trucks for long hauls and truck-tractors for short hauls. With hauls up to two miles no trouble was experienced in getting the mixture onto the grade without segregation on preliminary set. The disadvantages which were most evident were: (1) That hard roads are essential to continuous motor-truck operation; (2) that motor truck travel over finished subgrade necessitates a second finishing and rolling, and (3) that pumping and road side pipe lines continue necessary for curing the slab.

Toward the end of the year studies of plans for obviating these disadvantages had made progress. Wet-batch haulage by industrial railway was an obvious thought. This plan met the first two disadvantages but not the third. A more original plan was based on the reasoning that if the water in the wet batch could be prevented from escaping by absorption into the subgrade and by surface evaporation, the need of a water-supply on the grade would be eliminated. It was considered that this conservation of water might be effected by oiling the subgrade and by covering the concrete, immediately after finishing, with a thin skin of asphaltic material. Other considerations were the

use of lighter trucks and the use of pneumatic tires.

The mixer experience of the year demonstrated that: (1) For high-speed road construction, mixers of greater strength and endurance in details are essential; (2) a number of mixers are incapable of handling dry mixtures speedily. Without much doubt, the use of dry mixtures will be extended. Whether they will prevail elsewhere than on paper is an open question. Observations of many operations under dry-mixture specifications last year led one to wonder how much of the concrete which went into pavement slab came strictly within the requirements of a 2-in. maximum slump. In the circumstances, then, it may not matter whether great effort is made to improve mixers for handling dry concrete, but the improvement of their strength and endurance is essential.

Machine finishing of concrete slabs was a success wherever employed. It produced a well-compacted concrete and a smooth, even surface. As a labor saver it demonstrated its right to a prominent place among road-making machines, whether dry mixtures or wet mixtures be used. A sturdy side form is necessary, and the year's experience indicated that side forms need to be made heavier to remain firm under the vibrating travel of the finisher and not to develop a permanent set. An observation which merits attention is the action of the machine in flushing to the surface an appreciable depth of mortar above the stone. This is an advantage, or the contrary, as one approves a mortar surface or holds that tough stone, flush with the surface, is essential to resist wear.

Heavier Standards Required

Greater ability to endure continuous hard service is, in general, a requirement of highway-construction equipment. There are individual machines which do not need strengthening, but, in general, weight and strength must be added. The nature of certain operations is such that responsibility rests on a single unit and so, when that unit fails, work stops. Duplication of such units is expensive, but that is not the most disadvantageous feature, in road work, of this ordinarily successful insurance of continuous production. If a mixer has a minor-part breakdown, for example, the time required to move a duplicate machine several miles into the field is seldom less than would be required to repair the break. Duplication of plant is scarcely practicable except in the sense of providing spare machines and parts; and, therefore, road machinery needs to be exceptionally well guaranteed against accident by strong construction. A master mechanic and a repair gang and ample spare parts are further insurance required on every heavily outfitted road-construction operation.

Heavily machine-equipped operations characterized the year's highway-construction methods. Under the conditions prevailing, the year's record of performance did not establish the superiority of large-plant methods. Management becomes a greater factor of success in large-plant operations, and heavier equipment in general is required to guarantee the intensive service which is its fundamental idea. Continuous output requires factory methods in maintaining raw-material supply, in routing operations, and in keeping equipment in working condition. These are the broad acquisitions, from last year's experience, to the knowledge of road-construction plant with which contractors undertake the new year's work.

Enrollment in Engineering Schools Greater Than in 1917

Attendance Little Less Than That of 1918, Which Was Swollen by S. A. T. C.—Only Mechanicals Decrease

TO DETERMINE the present trend of engineering enrollment in the colleges, questionnaires requesting statistics on freshman registration and total enrollment in the five principal engineering courses for the college years beginning in 1917, 1918 and 1919 were sent by *Engineering News-Record* to 95 engineering schools. Of the institutions addressed, 85 answered, and of those answers, 74 contained sufficient information to determine their total engineering enrollment. Only 50, however, could be used to bring out comparisons for the three years in the five major engineering courses.

Engineering students enrolled in 74 colleges in the United States were totaled as follows: 23,167 in 1917; 34,122 in 1918; 33,937 in 1919. The corresponding freshman enrollment for those colleges was: 9,657 in 1917; 16,752 in 1918; 15,172 in 1919. The total enrollment gain of 1918 over the preceding year was 47%, while the 1919 total shows a loss of 0.5% from that of 1918. In the freshman registration of 1918 there was a gain of 73% over 1917; this year's freshman registration was 9% less than that of 1918. The total enrollment gain of 1919 over 1917 is 46%, while the total freshman registration gain of this year over 1917 is 57 per cent.

Although the questionnaire did not ask for it, several of the colleges inserted their 1916 figures, and from those it is estimated that the 1917 total enrollment in the engineering schools was about 25% below that of 1916, with freshman registration for 1917, however, only about 8% below 1916. In considering the large enrollment of last year, then, it must be noted that 1917 was a year of subnormal engineering student attendance. Also, the year 1918 was abnormal in that the Students' Army Training Corps increased both the total engineering enrollment and the freshman registration to an extraordinary degree. The engineering schools were asked for their enrollment figures as of the beginning of each college year and they included therefore the S. A. T. C. students. As the great majority of such students dropped out of their courses shortly after the signing of the armistice, the 1918 totals—as for a college year—are therefore, somewhat "watered."

It is known, then, from present data and from a canvass of the situation made in 1917, that the total engineering enrollment of 1917 was below normal, due to enlistment, the draft, and other causes, and the freshman registration of 1918 was unnatural in its extraordinary increase due to the S. A. T. C. Therefore, for the purpose of gaging this year's total engineering enrollment, 1917 and 1918 should be disregarded and a comparison drawn, instead, with that of 1916. Following that line, it is calculated that the total enrollment of engineering students for this year is approximately only 9% greater than that of 1916. This year's engineering freshman registration, however, is approximately 44% greater than that of 1916. The probable cause of the very large current freshman registration, nearly as large as the 1918 figure as distended by the S. A. T. C., was the delayed entrance of men in, or

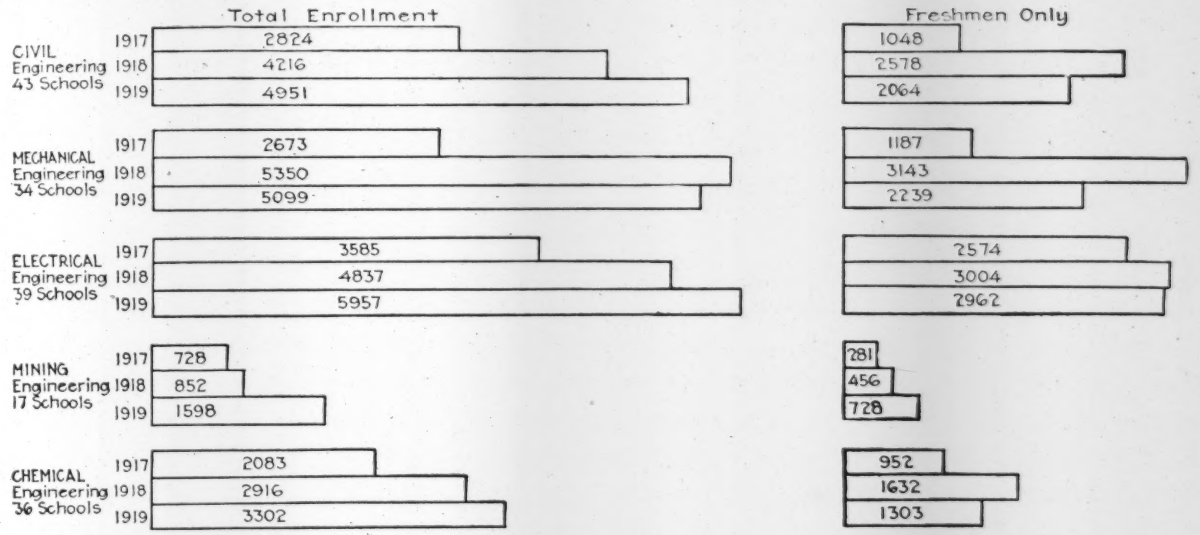

CHART SHOWS RELATIVE ATTENDANCE FOR PAST THREE YEARS IN 43 CIVIL ENGINEERING DEPARTMENTS, 34 MECHANICAL, 39 ELECTRICAL, 17 MINING AND 36 CHEMICAL

connected with, the military service during 1917 and 1918. It would be of value to know what portion of the S. A. T. C. attendance was really normal engineering attendance, but available data do not furnish that information.

In comparing enrollment and registration in the five major engineering courses for 1917 and 1918, the returns from 50 engineering colleges were found available in that they furnished the information desired. Fortunately, too, they are very well representative of the engineering institutions of the United States. The colleges whose information was used in compiling the accompanying chart are located in 29 states, as follows: 19 in six New England and Eastern states; 13 in five Central states; 7 in seven Southern states; 5 in five Western and Southwestern states; 6 in six Rocky Mountain and Pacific Coast states. Not all of the 50 schools offer courses in all five branches of engineering chosen to serve in a comparison; therefore the identity and the number of schools contributing to the total in each branch vary. Also, many of the schools offer courses other than those named in the questionnaire and used in the chart. The students enrolled therein are not included in the charted totals. No comparison in volume of enrollment can be made from the chart between the five branches of engineering, because of the fact that the figures for each have come from a different number of engineering schools.

The only comparisons set forth, then, are within each indicated branch of engineering, and consist of the 1917, 1918, and 1919 total enrollment figures and freshman registration figures for each. It is notable that mechanical engineering is the only branch which shows a decrease in total enrollment from last year. The explanation of such decrease, however, is offered in the excessive freshman registration of 1918, a large part of which, without doubt, was S. A. T. C. membership whose individuals have not enrolled this year. On the other hand, mining engineering is the only branch that shows an increase in freshman registration this year over that of 1918. This also is a circumstance which may be explained by the fact that the mining schools were affected to a very small degree by the S. A. T. C. during 1918. Electrical engineering shows the most consistent growth in total enrollment for the three years, with civil engineering second, mechanical, third, and mining engineering fourth in consistency. Except for mining engineering, electrical engineering had the smallest freshman loss this year, as it also had the smallest percentage of freshman gain last year, which facts are indicative that electrical engineering was less affected by the S. A. T. C. than was civil, mechanical or chemical engineering. It is curious to note that mining engineering, whose total enrollment has more than doubled in two years, has this year a freshman registration exactly equaling its total enrollment of 1917. A summation of the situation is to say that this year's total engineering student enrollment is about 9% greater than that of normal 1916; that electrical, civil, mining and chemical engineering have had consistent growth in enrollment during the past three years; and that mechanical engineering bore the greater part of the S. A. T. C. burden during 1918.

Priestman Wage-Fixing Scheme

A new plan for fixing wages has been devised by a firm manufacturing machinery in London, England. Information regarding what is called the Priestman scheme is contained in a recent issue of *Commerce Reports*. It was only recently made public by the Higher Production Council of Great Britain.. By this new scheme a standard of production is established; that is the amount of work produced by the ordinary effort of a certain number of men, this standard being the basis of pay. Through increased individual effort this standard can be exceeded, and every employee receives a percentage on his wages for all output in excess of his standard. It is explained that the friction often caused by piecework is thus eliminated, and a maximum output is more possible. The Higher Production Council describes the scheme as the "solvent of many, if not all, of the difficulties now facing industry." The firm initiating the scheme has increased its average output by 50% through the operation of the scheme.

The Railways—Financially and Physically

A Review of the Railroad Situation by a Student of the Problem Who Has Had Experience in the Financial, Operating and Engineering Departments

FACING the end of Federal control Mar. 1, 1920, the date set by the President in his proclamation issued Dec. 24, the railways today, like many veterans of the war, are "shot full of holes," "shell-shocked," "gassed" and all but ruined, financially, physically and morale-ly. It has taken ninety years to build up the splendid organization of our transportation systems, but in two short years that system has been disorganized, dismembered and disfigured to such an extent that it is scarcely recognizable. This is due directly to the centralization of control, which has taken away from the practical and efficient operating officials in the field the authority and initiative necessary to produce results. It will take years to recover from this condition.

The attempt to revise almost instantly the operation of 250,000 miles of railway, employing 2,000,000 persons, was an impossible task. The experiment has been proved not only expensive to the public but detrimental to our national prosperity. The necessity of operating the roads primarily in the interest of winning the war was paramount, but it would have been accomplished more effectively, at greatly reduced cost and without the disorganization of the railway systems, if it had been intrusted to a war board of eminent railway men, such as had control prior to Federal control, subject to the general supervision of such Governmental authority as may have been deemed essential to carry out the general policy of the Government.

The reorganization of the railways under Federal control by the appointment of regional directors, some of them charged with the operation of 130,000 miles of road, as was the case in the original Western region—later divided into three regions of about 45,000 miles each—was an impracticable plan. There is no man, however competent, who can possibly supervise such tremendous operations. The organization on so vast a scale broke down of its own weight. How much simpler it would have been to appoint each president as Federal manager of his own railway, with organization undisturbed, and give him the necessary authority, under a general, well defined policy, subject to a central board or commission of eminent railway men.

Where the Railways Stand

The railways find themselves at the end of two years of Federal control in the following unenviable situation:

Financially, their credit is seriously affected and they are, therefore, unable to finance their obligations, except by the aid of the Government.

Physically, their property and equipment are in a depreciated condition; recovery to the point of rendering adequate service to the public will require years.

In organization they are dismembered and disrupted; morale and discipline are seriously affected.

As for labor, last but not least, the roads are saddled with a burden imposed by national agreements with labor organizations which are so drastic in many respects as to be almost prohibitive of reasonable operation.

One ray of hope remains—that the public has had its lesson in the results of Government ownership and operation and will want none of it. If the experience of the past two years has prevented the calamity of Government ownership, it is worth the cost.

Financial Status

It was expected that railways, generally, would be able to finance their obligations under Federal control, provided their "standard return" was promptly paid and the results of operation indicated that at the end of Federal control the net results would be sufficient to guarantee the necessary funds.

The failure to make contracts promptly with the roads, coupled with the unsatisfactory financial results of operation under Federal control, soon made it difficult for the roads, many of them strong ones, to secure funds except through the aid of the Government. It was thought that the increase in rates would remedy the difficulty and produce net earnings sufficient to reestablish confidence in railway securities, but unfortunately the amount yielded by the increase in rates was absorbed by the increase in wages given railway employees, so that the deficits continued. It was also believed that if the Railroad Administration had early come to the relief of the roads in financing their needs, credit would have been maintained and financing could have been effected without Government aid.

The result, however, was that most of the roads were obliged to depend upon the Government for financial aid, which wiped out the first revolving fund and made another appropriation necessary. When it was found that the rate increases were all absorbed by increased grants in wages, prudence should have suggested a further increase in rates to make Government operation at least self-sustaining.

The credit of the roads, at the end of Federal control will be such as to make future financing, for most of them, an extremely difficult matter unless Congress makes provision to strengthen their position by adequate revenue and takes care of the obligations now due the Government from the roads.

As an illustration, most roads finance their additions and their betterment and equipment expenditures by issues of long-time securities. Surplus from earnings is not sufficient to meet the needs currently. Now if the roads must pay the Government out of their standard return, which represents their earnings, many of them will be out of funds. The Government must assist the roads in strengthening their impaired credit; otherwise their financial structure will be seriously affected, with disaster to the country.

Physical Condition

The railways find themselves at the end of Federal control, as compared with the beginning of that period, in a depreciated physical condition with respect to roadway, tracks, structures and equipment. During the first year of Federal control, due to the heavy demand for war purposes, the railways were taxed to the limit to perform their functions, and on account of shortage of labor and material the maintenance of the properties and equipment was below that of the average of the

"test period" (the three years which ended June 30, 1917). During the year 1919, on account of large deficits in operation, expenditures were curtailed in all directions, thereby adding to the deficiency in maintenance, so that the properties are in a greatly depreciated condition. As illustrating the serious physical condition of the roads, a few important items may be mentioned:

Rails—Normally it requires about 2,000,000 tons of steel rails per annum to meet the needs of the railways. The Railroad Administration has purchased directly only 200,000 tons of steel rails in two years, or 5 per cent of normal requirements. The corporations, fortunately, had some unfilled orders at the beginning of Federal control, otherwise the situation would have been even more critical.

Ties—The railways require annually about 100,000,000 ties. From present indications there will be a shortage, during the Federal-control period as compared with the test period, of about 25 per cent, or 50,000,000 ties.

Structures—There has been a large decrease during Federal control in maintenance of structures, such as bridges and buildings, fuel and water stations, largely due to shortage of labor and material and, during the past year, to curtailment of expenditures which in the aggregate will amount to millions of dollars.

Equipment—The Administration has purchased only 100,000 freight cars in two years and only about 90 per cent of these have been delivered. During the four years immediately prior to Federal control the railways built an average of 100,000 cars per year. The average retirement of freight cars amounts to about 80,000 cars per year, so that the Administration has purchased only about one-half as many cars during Federal control as was done by the corporations prior to Government operation, and for the past two years the retirements will exceed the replacements by about 60,000 cars. In addition to this, the freight equipment has not been maintained in normal condition, which means that at the end of Federal control there is not only less freight equipment but that much of it is unserviceable. With the large increase in tonnage which should be handled in 1920 and the probably prosperous succeeding years this situation is a serious one and will result in an extreme car shortage, with a detrimental effect upon our reconstruction period. It will require about 200,000 new cars in 1920 to make good the deficiency.

Locomotives—The Administration ordered 1415 new locomotives in 1918 and later 600 additional, or 2015 in the past two years. These locomotives have not all been delivered to date. The normal requirements are approximately 3000 additional locomotives per annum. During Federal control only 2000 locomotives have been added, or about one-third the normal requirements. It is difficult to see how the traffic of 1920 can be handled with the present locomotive equipment. Moreover, the power has not been maintained in as good condition during Federal control as prior thereto, due to the same causes as apply to freight-car equipment.

Passenger Cars—On June 30, 1916, in the Test period, the total passenger-car equipment consisted of 54,774 cars, and in December, 1918, it was 55,697, or an increase of only 923 cars. On account of troop movements, passenger equipment was so intensively used during the test period that it was not possible to release it sufficiently for necessary repairs, with the result that there is a large depreciation in its condition at the end of Federal control. The requirements for new passenger equipment will be at least twice the normal for the year 1920; in addition, the deficiency in maintenance of present equipment must be made up.

Improvements and New Lines

During the first year of Federal control, 1918, the Administration had an ambitious program for additions and betterments, totalling about $1,250,000,000, but, owing to the shortage of labor and material, less than 40 per cent, or $430,000,000 was expended during that year. (In 1917 $572,000,000 was expended by the railways.)

During 1919, following the armistice, the additions and betterment program was largely curtailed, owing to the heavy deficits in operation and depletion of the revolving fund, and it is estimated that less than $300,000,000 was expended in 1919.

In some instances, improvements which were uncompleted were discontinued, and in others cancelled entirely. Much improvement work was stopped, owing to the requirement by the Administration that the corporations should finance the work from their own funds, which they were unable to do, owing to their inability to finance themselves. The result has been that in the two years of Federal control only about one-half the normal expenditures will have been made on improvements. In order adequately to meet the transportation needs of this country, from $1,000,000,000 to $1,500,000,000 will be required annually for the next five years.

In the matter of new lines and extensions, less mileage was added in 1918 than in any year for the past thirty years. Only 721 miles were built, of which 55 miles was in Alaska. Most of the mileage built was projected by the companies before Federal control. In 1914, 1500 miles, and in 1915, 1916 and 1917 approximately 1000 miles were built each year. There has been no incentive for capital to invest in railways, owing to the ever-decreasing margin between revenue and expenses, due to the mistaken policy of the Interstate Commerce Commission respecting rates.

The single-track mileage reported in operation Dec. 31, 1918, was 250,473, as against 252,029 on Dec. 31, 1917, a decrease of 1556 miles.

There are many regions sorely in need of transportation facilities which cannot be provided, owing to the unsatisfactory financial situation confronting the roads. The oil regions of Oklahoma and Texas are today restricted to about one-half their capacity output because of lack of transportation facilities. Many similar cases will arise when the country resumes its normal activity. If the railways cannot profitably operate their present mileage, whence will come the capital to provide additional lines?

Railway Labor Situation

The Director General, at the beginning of Federal control, encouraged railway employes to organize, to present their demands and make agreements covering wages and working conditions. Labor is entitled to a fair deal, but when that condition is met it is time that the public, including the owners of railways, should have consideration.

In May, 1918, General Order 27 was issued, and since that date numerous supplements, addenda and interpre-

tations thereto have appeared. As the result of these increases, the annual cost of railway labor is advanced to approximately $1,200,000,000 over 1917. If the element of inefficiency of labor now, as compared with the pre-war period, is considered, it means that the annual labor cost is increased about $1,500,000,000 over 1917.

The total interest charges on funded and unfunded debt of the United States railways for 1917 was $431,000,000, and in 1918 $434,000,000, which means that the annual increase in wages to railway employees made during Federal control is equal to three and one-half times the interest on the indebtedness of the properties.

The dividends paid in 1916 on roads now under Federal control amounted to $337,000,000, or less than one-fourth the amount of annual increase in wages under Federal control.

The aggregate of interest on bonds and dividends on stock per year amounts to approximately $750,000,000, or about one-half the increased cost of labor per year under Federal control as compared with private control. In brief, the combined returns to capital of $18,000,000,000 invested in our railways is only about one-half the annual increases granted to railway labor under Federal control.

Why There is a Deficit

These are startling statements, but they are facts. They alone are sufficient to explain the large deficit in operation during Federal control.

The increase in freight and passenger rates made in June, 1918, is equal to about $900,000,000 per annum, and it was expected that this would meet the increase in wages to railway labor. The increased cost of railway labor alone will be easily one and one-half times the increase in rates.

Even in the face of these pertinent facts, the Director General has declined to ask for further increase in rates, because he thinks such a request would affect the cost of living, yet at the same time new increases in wages and working agreements are being made. These are burdens under which the railways must struggle when they are returned. It is the evident purpose that every craft and employee on railways shall be thoroughly organized before the end of Federal control. The conditions which are being included in these agreements are in some instances so impracticable as to be unworkable, except at prohibitive increases in labor costs. The practice of allowing "back pay," which in many cases was not expected, has cost the Administration several hundred millions, contributing to the deficit which the patient taxpayer must meet.

Railway labor receives higher pay here than in any other country. The total amounts to 54 per cent of the gross revenues. In England labor receives only 34 per cent of the gross. The compensation of American railway machinists has increased 135 per cent in the past three years. Moreover, the annual increase given railway labor during Federal control is about one and one-half times the standard return paid to the railways by the Government for the use of their properties. It is readily seen why the railway labor organizations demand a continuance of Federal control.

If railways are not given consideration, by increased rates, to meet these enormous increases in costs of operation, there will not be a solvent railway within a year after Federal control ends.

The railway problem is very simple if reduced to its lowest terms. No business can live if the expenses exceed the revenues, and it is plain that this condition confronts the railways at present. Unless an immediate increase in rates is given they cannot perform their functions.

The increase of 25 per cent in freight and 50 per cent in passenger rates has not been sufficient to meet the increase in wages and cost of materials. It can be easily determined what further increase in rates is necessary to meet the requirements. It is very evident from the situation outlined above that at least a further increase of 25 per cent in freight rates is necessary to make up the deficits in operation and give a fair return on the capital invested. If this were done, the railways would take care of themselves and the entire problem would be solved.

The Cummins bill which has just passed the Senate is a step in the right direction, and although in many respects imperfect, it would meet the situation until experience makes changes necessary. But the Cummins bill is so vastly different from the Esch bill, which has passed the House, that it may suffer changes in conference so radical that the amended measure will not meet the situation.

If the railways are returned without provisions to enable them to earn enough revenue to carry themselves a financial situation that will seriously affect the whole nation will be created. If the railways are properly provided for, the country will forge ahead and profit by the greatest industrial expansion that has ever been known.

The future of the railways and the welfare and prosperity of the country are so inextricably bound together that whatever be the fate of the former must be the fate of the latter. It is confidently expected that the great common sense of the American public will assert itself and insist upon a square deal for the railways.

Traffic on New York's Transit System

More than 2,000,000,000 persons rode on the elevated, subway and trolley lines of New York City during the fiscal years 1918 and 1919, according to figures compiled by the Public Service Commission for the First District. This is the largest traffic figure in the history of the city and represents an increase of nearly 104,500,000 over the previous fiscal year. Only two other years exceeded 1918-1919 in the amount of increase in traffic. Had it not been for the ravages of the influenza epidemic in the fall of 1918, it is fair to assume the increase for 1918-1919 would have been greater than in any other year, inasmuch as the increase from December, 1918, to June, 1919, inclusive, was 122,500,000. From this total, however, must be deducted a loss in traffic for the first five months of the fiscal year amounting to 17,000,000 passengers, of which the loss was 12,000,000 in October. The total increase was divided, 98,751,618 for the rapid-transit lines and 5,679,197 for the surface lines. The percentage of increase for all lines was 5.29. On the rapid-transit lines the percentage of increase was 8.93 and on the surface lines 0.65. The increase in passenger traffic brought a corresponding increase in revenue; but this latter increase was offset by operating expenses, which increased at a very much higher ratio, causing all the companies a total deficit in net income of $8,085,019.

Present Status of Flood Protection

By C. B. Burdick
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THE great floods of 1913 brought to a head many projects for flood relief that had been receiving more or less attention for many years. A great disaster was required to furnish the impetus necessary to carry the projects to the construction stage. The lesson, though costly, was sufficiently effective so that a start has been made on the construction program.

The Miami Conservancy District is going ahead courageously, in the face of the recent higher prices, with its program for detention reservoirs and channel improvements, running into upwards of $25,000,000, estimated on a pre-war basis. Columbus is at work upon its program for expending $3,500,000 to secure partial protection by enlarging the Scioto River channel within the city. Erie, Pa., is proceeding with structures for protection against the floods of Mill Creek, and Augusta, Ga., has just completed a $2,000,000 expenditure for levees. At Kansas City, the Kaw Valley Drainage District, through ten years of litigation, has succeeded in greatly improving the channel of the Kansas River within the city, including reconstruction of the numerous bridges and building of levees. This work has not reached the stage where complete protection is effected, and in the past winter voters turned down a $1,600,000 bond issue to complete the protective works.

Progress Made in Solution of Problems

The publicity occasioned by the great Ohio floods and the thorough studies which followed no doubt have served to direct other localities to the consideration of similar problems. While most of these problems have not as yet progressed beyond the investigation stage, advance is being made toward the solution.

In the St. Louis district, the City of St. Louis has prepared plans to inclose River Des Peres where it passes through the city, draining 110 square miles, largely suburban and rural territory, estimated to furnish about 40,000-sec.-ft. in flood. Across the Mississippi, at East St. Louis, the East Side Levee and Sanitary District has just completed studies which will solve the problem of the floods originating in the district, and upon the hills behind it, requiring improvements estimated to cost in excess of $2,000,000. Decorah, Iowa, presents an opportunity to construct a small detention dam which will protect the city against floods of Dry Run at a relatively small expenditure. Council Bluffs, in the same state, is another city where a small stream finding its outlet from the hilly country through the business district has caused damage and nuisance for two generations. It is expected that construction will be undertaken to the extent of about $1,000,000 during the coming year to correct this situation.

The recent studies of the detention basin, and the added knowledge in reference to floods that has been obtained in recent flood investigations, have made it desirable that some old problems be reconsidered in the light of later data. Every year something is added to the store of knowledge relating to the computations of floods and the measures for correcting them. Engineers will perform a valuable service to their communities and to engineering in general by measuring floods where the opportunity is offered, and assisting to record the related data that will make the information most useful to the science of hydrology. Progress is to be looked for in more extensive installation of rain gages and stream gages, and compilation of systematic records therefrom. Information relating to the storms and floods of watersheds of moderate size (say from 500 to 5000 square miles) has already been greatly increased through the Miami and Scioto studies. More information is needed concerning the watersheds of 100 square miles and less, which are affected by storms of an entirely different character.

Large Contractors Seek Reforms in Highway Contracting

First Season's Experience Proves Unsatisfactory—Higher Prices Must Be Asked if Present Conditions Continue

By C. S. Hill
Associate Editor, *Engineering News-Record*

A SEASON'S experience in actual construction has strengthened the conviction of large construction companies that changes are necessary to make highway contracting attractive. These companies assert that road contracting in 1919 has not paid; that construction progress has been unprofitably slow, and that, with conditions as they are, many organizations which have undertaken road construction in 1919 will not undertake further contracts except at increased prices. However, they say, furthermore, that with conditions changed in ways which they believe are open to road officials, increased prices may be unnecessary for a reasonable profit and progress may be accelerated.

As disclosed by inquiry last spring (*Engineering News-Record* of June 12, 1919, p. 1150), the disposition of managers of large contracting organizations was to undertake highway work as a stop-gap until construction activities were resumed by the railways and other private industries normally providing heavy construction contracts. The politics, narrow business practices and petty contract restrictions of highway work were cited as objections to permanent engagement. Six months' operation as indicated above has not greatly modified the original attitude of large contractors, but it has enabled them to estimate more accurately the strength of the various obstacles to profitable contracting which present conditions impose and to formulate somewhat precisely the changes in practice which are deemed essential.

Changes Specified

As formulated in the minds of construction managers, the changes needed to improve highway contracting conditions are classified under the following: Contract practices, materials supply, and plans and specifications. The points here made have been gathered in conference with contractors. Most of them have also been put forth in a memorandum addressed by the Associated General Contractors of America to the American Association of State Highway Officials.

To attract large construction organizations, highway contracts should be let in as large mileages as are practicable and should extend over more than one season. That in awarding contracts there should be the most careful investigation of the contractor's experience, organization, past performance and financial ability, and award should be made only to a contractor whose ability to accomplish the work, giving due consideration to its magnitude and difficulty, is beyond

reasonable doubt. Contracts should comprise all work on the project—grading, paving, bridges and culverts—and should be let undivided. Until it has been definitely decided to undertake construction, bids ought not to be asked, and when bids are received contracts should be awarded within 10 days. If all bids are rejected, the lowest bidder should receive, as compensation for his estimate, ½% of his estimated cost of the work. Under present practice, flagrant abuses exist in asking bids merely to obtain prices and in holding guarantee checks for weeks and sometimes for months. Since large highway construction operations call for extensive preparatory work, assembling plant and materials and formulating construction plans, contracts should be awarded in the autumn, to insure an early spring start of construction.

State aid in obtaining materials, and not state supply, meets greatest favor from large contractors. They ask, therefore, (1) that state supply of materials be discontinued; (2) that the use of local aggregates be encouraged by materials surveys; (3) that estimates be allowed on materials in stock pile and be based on the total cost of materials and of handling; (4) that, whenever it is practicable, state inspection of road materials should be at the source, and (5) that highway departments should bring their full influence to the aid of the contractor in obtaining cars for the shipment of road materials.

To get close estimates, plans should be accurate and complete and should be ready for the contractor at least three weeks in advance of the date of receiving bids. Whenever changes in plans, after the contract is awarded, require increased work or involve delay, the extra work and the time lost should be paid for. On force-account work, the percentage paid the contractor should be computed on the total cost. When work is turned over to public use, it should be accepted and paid for in full, and the contractor should be relieved of responsibility for maintenance. Retained percentages should never exceed 10% of the cost of the contract.

None of the changes which have been enumerated, it is contended by contractors, asks of highway officials anything which engineering practice has not sanctioned. It is possible to demonstrate by examples that each one relates to a condition where abuses exist. All are considered to be mutually for the benefit of the public whose money is being expended, of the engineers who are directing this expenditure, and of the contractors.

Contractors Must Control Work

Coördination of operations is absolutely essential to economical and uninterrupted progress in constructing paved roads. Divided control of operations hinders coördination. Control is divided (1) if one contractor performs certain units of the work and another contractor performs the remaining units; (2) if one party to a contract furnishes the materials and another handles and places them. The large construction companies, therefore, desire contracts covering all structures involved in any piece of road work, and object to any policy by which road officials furnish cement or aggregate or any other major construction material.

State-furnished materials have, it is considered, proved a drag on progress. The ordinary highway department functions slowly. It is chiefly concerned in getting the material at lowest cost. It is hobbled by red tape when emergencies demand quick action. It has no clear way of expediting movement by taking advantage of spot material at a price advance.

The contractor is restricted in none of the respects named. He is not wholly concerned in getting his material cheaply. His objective is finished construction, and if a premium wisely disposed helps, by expediting materials delivery, to finish construction more rapidly, he wants the unrestricted power to adopt that resort. He wants to buy when and where he pleases; to concentrate or to distribute his orders; to demand and to grant concessions. Unless there is this control, one of the chief functions for which his large organization has been perfected is taken away, and the power of the large contractor to conduct large operations is nullified.

State-furnished road materials, the large construction companies consider, is a close second to the "lowest-bid" doctrine in encouraging the tyro in contracting. These conditions, in some sections, it is pointed out, have ruined the credit of road contracting. They are multiplied by every additional action which makes contract getting easy, and state purchase and supply of materials does this. The theory that by throwing wide the doors to road contractors, the program of road construction is speeded up is held false. What is required from the state is not generosity in bestowing contracts but aid in helping the proved contractor, who has work, to hasten construction and earn a profit.

Modify Plans To Meet Emergencies

Unless road officials exercise their discretion, as railway engineers and the engineers of other large employers of contract work do habitually, when the emergency arises, to modify the letter of the specifications, in order to simplify an immeasurably greater problem, the large general contractor contends that he cannot do road work at last season's contract prices and will withdraw from the field as fast as opportunities offer themselves in his original fields of activity. Claims urged by highway officials that they cannot delegate such important discretionary powers to the ordinary inspector, or think it unsafe to permit their exercise by any except the most competent engineers, are met with the final contention of the contractor:

More engineers and salaries great enough to secure the best trained engineers must be provided in order that: (1) Plans for construction shall be completed well ahead of contract lettings, which is not being done; (2) plans shall be complete and accurate, which is not now the fact; (3) decisions affecting speed and profits shall be rendered promptly and finally, which is not now the practice.

In general, then, while a goodly number of large contractors heretofore specializing in other lines have taken highway contracts during the past season, their experience to date has not led them to the conviction that they want to stay permanently in road contracting. Conditions are still far from being as satisfactory as those found on private work. The large contractors, seeing the large program of highway work ahead, are desirous of seeing such reasonable changes made as will allow them to regard highway work as one of their specialties. But unless the changes which to them appear reasonable and possible—because the desired conditions obtain on private work—are made, they will return to other lines as rapidly as they can.

Engineering and Adventure—

A Plea for a Return to Individualism as Against an Overdose of "System."

By P. B. McDonald
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MANY young men choose engineering as a profession because it suggests adventure. Young men of Anglo-Celtic ancestry are particularly inclined to seek work that interests them, rather than to reconcile themselves to the laborious plodding that characterizes German method. The yearning for adventure is perfectly natural and fitting in a young American—or, for that matter, in an old American. The man who discovered America took a chance, as did the early settlers and pioneers, and it is not strange or discreditable that their descendants should hanker for the unknown, the far-away, and the romantic.

Yet the vigorous young graduate from an engineering college finds his superiors advising him to settle down and form a rut. Industrial officials frown upon adventure. To them an adventurous spirit is the cause for making machinery "foolproof." The young graduate is put to counting cars or copying maps or sampling ore-bins. This is the "valuable experience" which is to compensate for his small salary. His spontaneity is deadened, and he comes to consider his youthful ideas of engineering as all wrong. Perhaps a few years of drudging so sour him that, when he becomes a boss, he takes out his bad temper on the young graduates who come to work under him.

More serious is the effect upon workmen of putting them in charge of a boss who has become constitutionally opposed to anything interesting, different or adventurous. Ruskin pointed out many years ago, with that strange capacity for seeing into the future that some Victorians possessed, that the subdivision of labor when carried to extremes would make for unrest and discontent. A man that spends his days and years sharpening the points of pins is likely to provide receptive material for bolshevistic theories, even though his wages seem high. That same man's ancestors worked longer hours for smaller wages, but took their work more leisurely and saw more of interest in it, because their tasks were varied and invited originality. Writers on the Middle Ages tell us that in the Merrie England of that period men left their work reluctantly and dreamed of their plans for the morrow. The Gothic cathedrals are beautiful and inspiring because the workmen were allowed to express themselves. The work was not drudgery. Every trade had a guild, somewhat in the manner of the modern trade unions, but the spirit of labor was quite different from that of today.

The point is that it may not be entirely the fault of the employee if he is discontented. The employer has thought very little, if at all, about making work interesting for his subordinates. In the case of engineers, officials seem to take a malicious pleasure in showing the young man that there is no adventure in engineering, that it is all a sordid grinding of the nose, that spontaneity and originality are faults, not assets.

Of course, the employers are partly right. Life does not consist of always running to a fire, as Woodrow Wilson has pointed out. Much youthful enthusiasm is misdirected and sophomoric. But engineering, or life itself, need not be entirely a grind. If work can be designed to utilize the spirit of advanture inherent in American youth, the greatest possible effort should be made to permit the expression of such desires. As C. R. Mann says concerning engineering education, "the fundamental thing is to get the boys to want to do it."

The brief military experience of the United States during the late war showed very well what a difference enthusiasm makes. While there was a chance of adventure, young men were eager for the Army and would do marvels; after the armistice was signed, everyone was anxious to be discharged as soon as possible.

Speaking generally, adventure is a state of mind. A fat man living in a back street in Brooklyn may have it, while a young fellow traveling among gold mines and opera bouffé and señoritas may be absorbed in getting back home to the old, familiar routine. Probably the fat man would be the more interesting to work for. In reading the articles contributed to technical periodicals by prominent engineers, it is not difficult to distinguish those that see work in the light of romance and those that see only the grindstone. According to the blue laws of people of no imagination, the more dry-as-dust an engineer is, the more successful he is. Such, however, is not always the case, as is shown by the records of engineering life.

Engineering as a profession should invite creative imagination, diverse individualities, men with new ideas. There is no profession offering more real opportunities for adventure if properly encouraged. Engineering can take men to the ends of the earth, to exotic, colorful places where romance is in the atmosphere and each day is an adventure. The engineer in his laboratory is frequently probing the unknown, and, if his time is not taken completely for routine, he can adventure into worlds as interesting as those to which the traveler goes.

H. G. Wells (who occasionally has a bright intuition) maintains that, instead of the world being made "safe for democracy," it should be made as favorable as possible for personal adventure. People need adventure, and the nation which best supplies its people with opportunities for attaining their aspirations, both conscious and unconscious, will grow most powerful and persist the longest. A. J. Balfour suggested in one of his essays that the real cause for the downfall of Rome, of which dissipation and vice were only the outward sign, was that the ideals foisted upon the Roman people by its government were too Oriental to satisfy Western minds. American industry, likewise, may have become too Prussianized.

Perhaps the English people have best understood the desirability of encouraging the natural craving for adventure. Their financiers have taken chances in all parts of the world on all kinds of ventures. They have not been afraid to speculate in rubber in the East Indies or Africa, in tea in Ceylon, in railroads in South America, and in gold mines in any part of the world. A Harvard professor recently suggested that one reason why London deals in more commodities than does New York is that the American investor will not take the chances that an English investor will. The variety of stocks traded on the New York exchange is narrow compared with the extraordinary range of interests on the London exchange. We are not so adventurous or so individualistic as the English.

President Hadley of Yale pointed out in a recent ar-